CHAPTER 6

DIVING AND SUBMERSIBLES


Floating Platform
EIRIK RAUDE
EIRIK RAUDE
EIRIK RAUDE
NASSAU


Floating Platform


SHELL/ESSO
48/19a CLIPPER

Floating Production System


ALDOMA


CORMOR ANT-A

DIVING AND SUBMERSIBLES

- Offshore installations used in the oil and gas industry lie largely beneath the seas and are constantly in need of *construction, inspection and maintenance*;

- The industry is heavily dependent on *diving and submersibles.*

Diving

- Commercial offshore divers are highly trained people who work on offshore oil rigs and diving support vessels (DSV's).

- They may perform such tasks as welding underwater.

Three main respiratory problems can occur in diving operations:

- Hypercapnia (carbon dioxide excess)
- Hypoxia (oxygen shortage)
- Oxygen poisoning (excess of oxygen)

That is the situation in which the tissues have an excess of carbon dioxide.

This can be caused by an excess of carbon dioxide in the breathing medium, the inability to remove carbon dioxide from the breathing medium, or the inadequate removal of carbon dioxide from the tissues or blood.

Excess carbon dioxide may cause perceptive changes and discomfort, up to dizziness, stupor and unconsciousness.

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This leads to unconsciousness and if oxygen is completely cut-off for 3 to 5 minutes, irreparable damage to the brain is experienced

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Diving operations may be divided into two categories which are dictated by water depth:

- Air diving techniques
- *Saturation diving*

Air diving

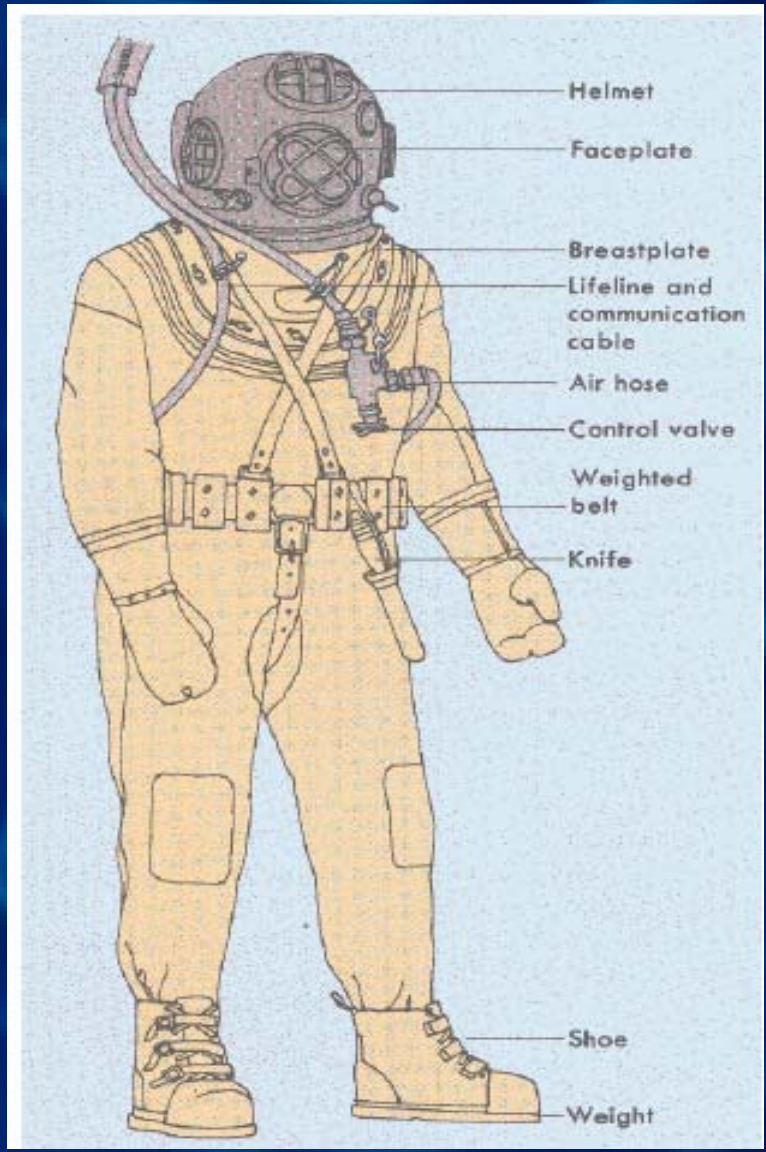
- Air diving is used primarily for dives of short duration in water depths of less than 50 meters.
- It is used for the vast majority of underwater inspection and repair programmes carried out in shallow water.
- Dive duration is limited dramatically with increase in depth and at 50 meters a stay of only 10 minutes is permitted

There are two air diving methods:

- Surface-supplied diving
- SCUBA diving

Surface-supplied diving

- diving with compressed air supplied from the surface.
- The diver is separated from the supply of fresh air, which is kept on the surface.
- Air reaches the diver through a long umbilical, which in its simplest form ends in a regulator and mouthpiece carried by the diver.
- The umbilical leads into a dive suit or some larger enclosed space containing the diver.
- Devices in this category include, diving belts, and rigid-helmet diving suits,


Helmet
Faceplate
Breastplate
Lifeline and communication cable
Air hose
Control valve
Weighted belt
Knife
Shoe
Weight

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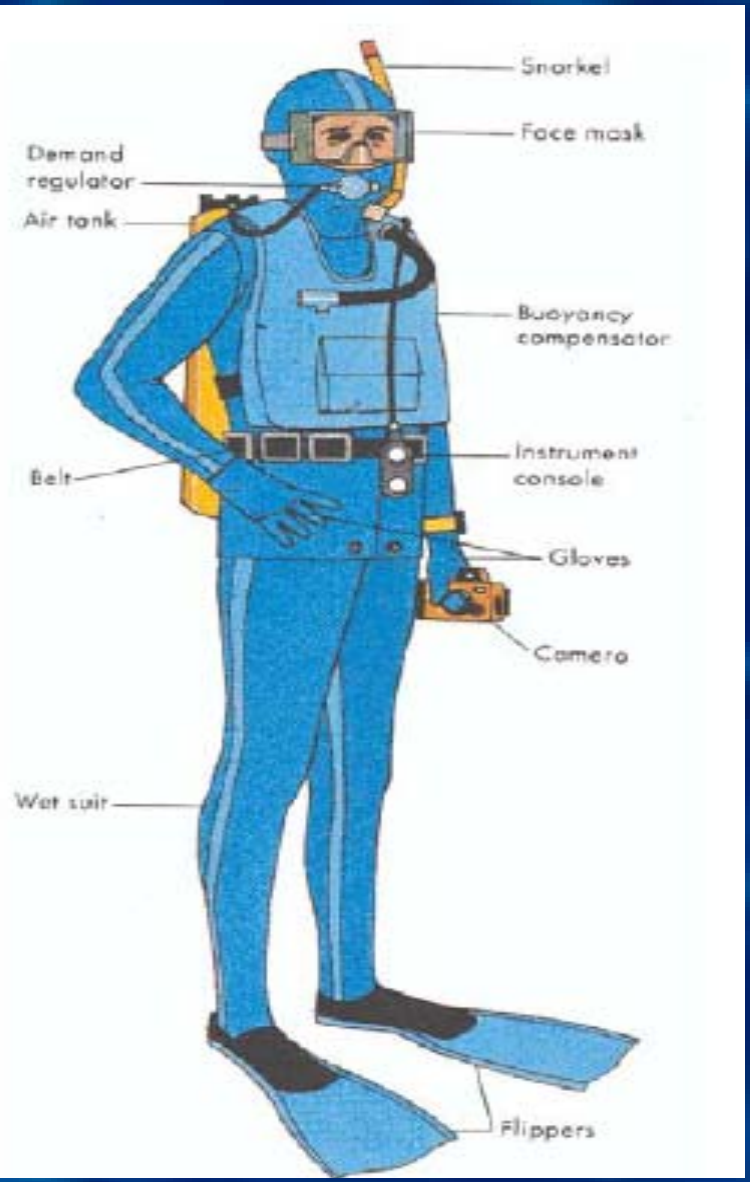
SCUBA diving

- Diving with compressed air or other gas mixture that is carried by the diver.
- SCUBA stands for Self Contained Underwater Breathing Apparatus.
- There are two principle types of SCUBA: open and closed circuit
- Open circuit vents all expired air into the water, and is the mode used in recreational diving.

- Closed circuit systems, in which exhaled air is recreated after carbon dioxide is absorbed and oxygen added, were widely used before open circuit became available, particularly by military divers who wished to avoid showing any air bubbles.



SCUBA diving

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Saturation Diving

- The divers are transported to the work site within a *diving bell*.
- At the site, the divers enter the water through a hatch in the base of the bell having first put on helmets/masks and attached their umbilicals to the distribution manifold on the inside of the bell.
- The umbilicals provide the diver with breathing gas and a supply of hot water to heat the diving suit.
- The divers may spend up to 8 hours inside the diving bell where they can eat and rest

- On completion of work the divers return to the bell, lock the hatch and are winched back to the diving support vessel (DSV).

- They are then transferred to the *Deck Decompression Chamber* (DDC).

- Throughout the operation, the divers remain under pressure. They may remain for a period of three weeks after which they commence *decompression*.

- Decompression involves the gradual reduction of the pressure within the DDC to atmospheric. It takes approximately one hour per meter of water depth to effect safe decompression, thus a saturation depth of 180 meters requires a decompression interval of nearly a week. A maximum depth of 500 meters is possible.

How to overcome?????

One Atmosphere Diving Systems ADS

- One atmosphere diving systems (ADS) were developed to overcome the difficulties associated with decompression.

- The diver in these systems remains at one atmosphere pressure and can work for relatively long periods without having to spend days in decompression. The diver uses manipulators to perform the necessary work.

- A modern extension of the one atmosphere vessel is the self-contained armored diving suit, flexible yet able to withstand pressures at depth: in effect, the diver becomes almost like a small submarine. With these one-atmosphere suits a diver can work at a depth of up to 1000 meters.

Diving Equipment

- Surface-supplied diving, also called hard-hat or helmet diving, affords commercial divers an unlimited air supply; a compressor connected to a surface reservoir provides the air to the diver's mask or helmet through a long, flexible tube (umbilical).

- The diver also wears *bailout* tanks in case of malfunction with the air supply.

- The equipment used in helmet diving is cumbersome and hampers mobility, making it difficult to perform tasks with the arms, such as moving heavy equipment underwater.

- Scuba divers wear a metal tank filled with compressed air, and a regulator that attaches to the tank.
- The regulator reduces the pressure of the air to match the surrounding water pressure, so that the diver can breathe the air comfortably. The regulator also distributes the air among four hoses.

- 1. One hose delivers air to a mouthpiece, through which the diver inhales and exhales.
- 2. Another hose from the regulator attaches to an adjustable air bladder called a buoyancy compensator (or control) device (BCD or BC), which the diver wears as a vest,
- 3. A third hose attaches to pressure gauges that divers use to monitor how much air remains in the tank.
- 4. A fourth hose attaches to a backup breathing device called an alternate air source, or *octopus.*

- Divers also wear a belt with lead weights to help them descend and stay underwater.

- The weights are spaced evenly around the belt for balance. Most divers carry from 5 to 20 lb (2.3 to 4 kg) of weight, depending on their body weight, the suit they are wearing, and where they are diving (buoyancy is greater in saltwater than in fresh water). A quick-release buckle enables the diver to shed the belt and rise to the surface in an emergency.

- Emergency equipment includes a dive knife, in case the diver becomes entangled in fishing line or marine plants, and whistles, lights, or signalling devices, in case the diver is lost or swept out in a current.

Diving Bells

- The diving bell provides transportation to and from the work site. It is secured to the DSV by a steel cable and an umbilical providing the occupants with breathing gas, heated water, electrical power and communication facilities.

Deck decompression chambers

- A DDC provides an out of water home for up to 6 divers for the duration of the diving programme.

Diving suits

- Diving suits used for offshore inspection and repair programmes fall into two categories largely dictated by the degree of thermal protection required by the diver.

- a) Dry suit: it is a watertight suit under which the diver wears thermal clothing. In a cold environment it is suitable for air dives of short duration.

- b) Wet suit: for saturation diving, a heated wet suit is required.

Heliox

- Air consists primarily of oxygen and nitrogen and both these gases cause problems when ingested under pressures associated with water depths greater than 50

meters.

Oxygen becomes toxic and nitrogen leads to *drunkenness of the deep*.

- Heliox, a specially formulated mixture of helium and oxygen provides a solution to both these problems since it permits the quantity of oxygen to be regulated to suit

the body's respiratory needs at a particular depth

Manned Submersibles

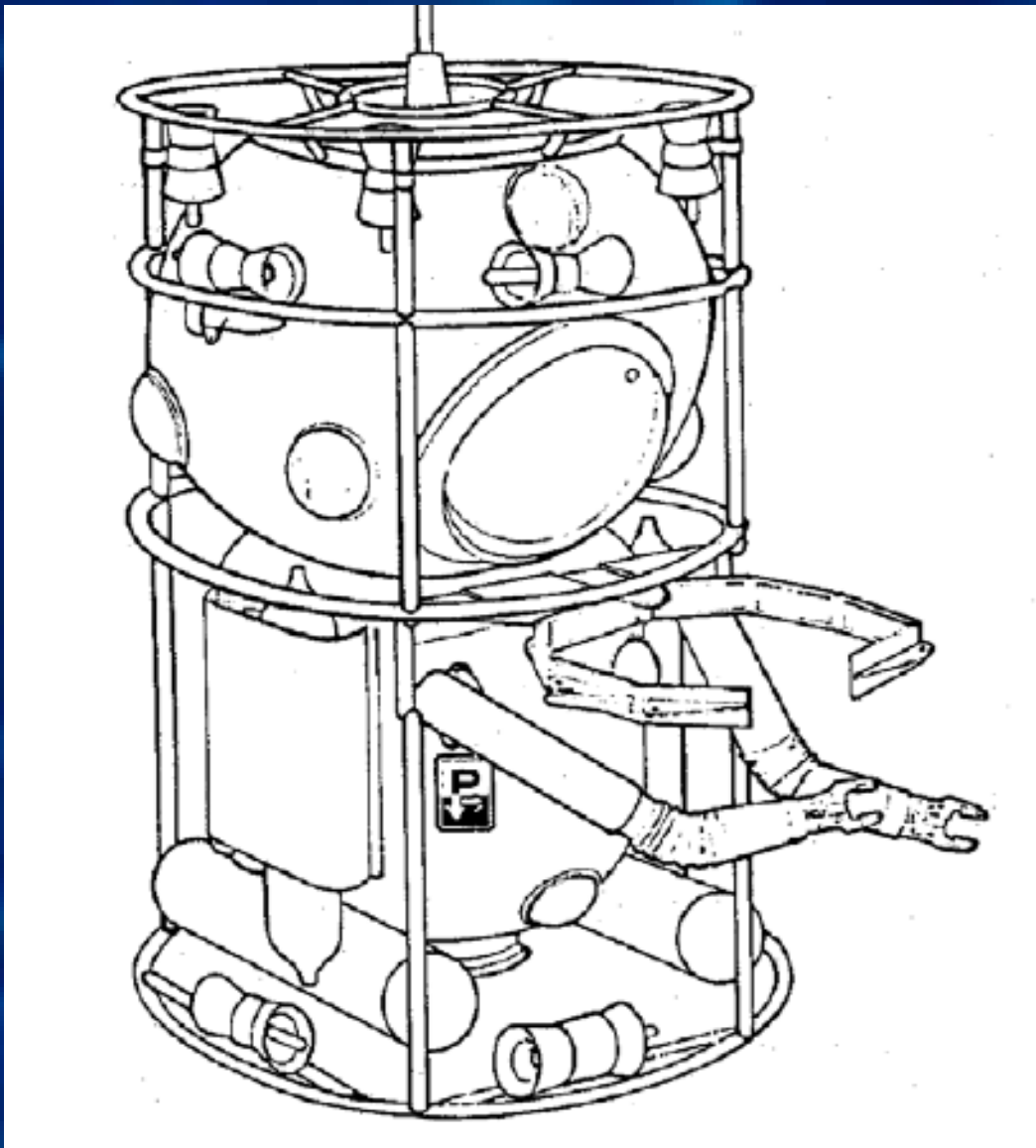
- Submersibles are pressurized vehicles that maintain surface air pressure inside while they descend deep into the ocean.
- The most common type of submersible is a submarine.
- Smaller submersibles are used in deep diving to transport divers to and from work sites.

- Submarines supplement divers and extend underwater surveying capabilities. They are fitted with video, high-intensity light sources, sonar sensors, and manipulators.

- A mobile diving unit (MDU) incorporating variable buoyancy and high power propulsion is an example of a manned submersible.

- The MDU shown below is a six-man vertical configuration submersible.

- It has two diving chambers each capable of carrying three men. It is equipped with thrusters for mobility. An umbilical provides power, heat and gas (heliox). It comes with manipulators, diver operated welding equipment, water jetting equipment, external area lights, video and photography systems. It is capable of operating to a depth of 350 meters in up to a



- Remotely operated vehicles ROVs and autonomous underwater vehicles AUVs now do the work of manned submersibles in most oilfield applications, because of cost issues related to insurance, manning requirements and vehicle and handling system complexity.

Unmanned Submersibles

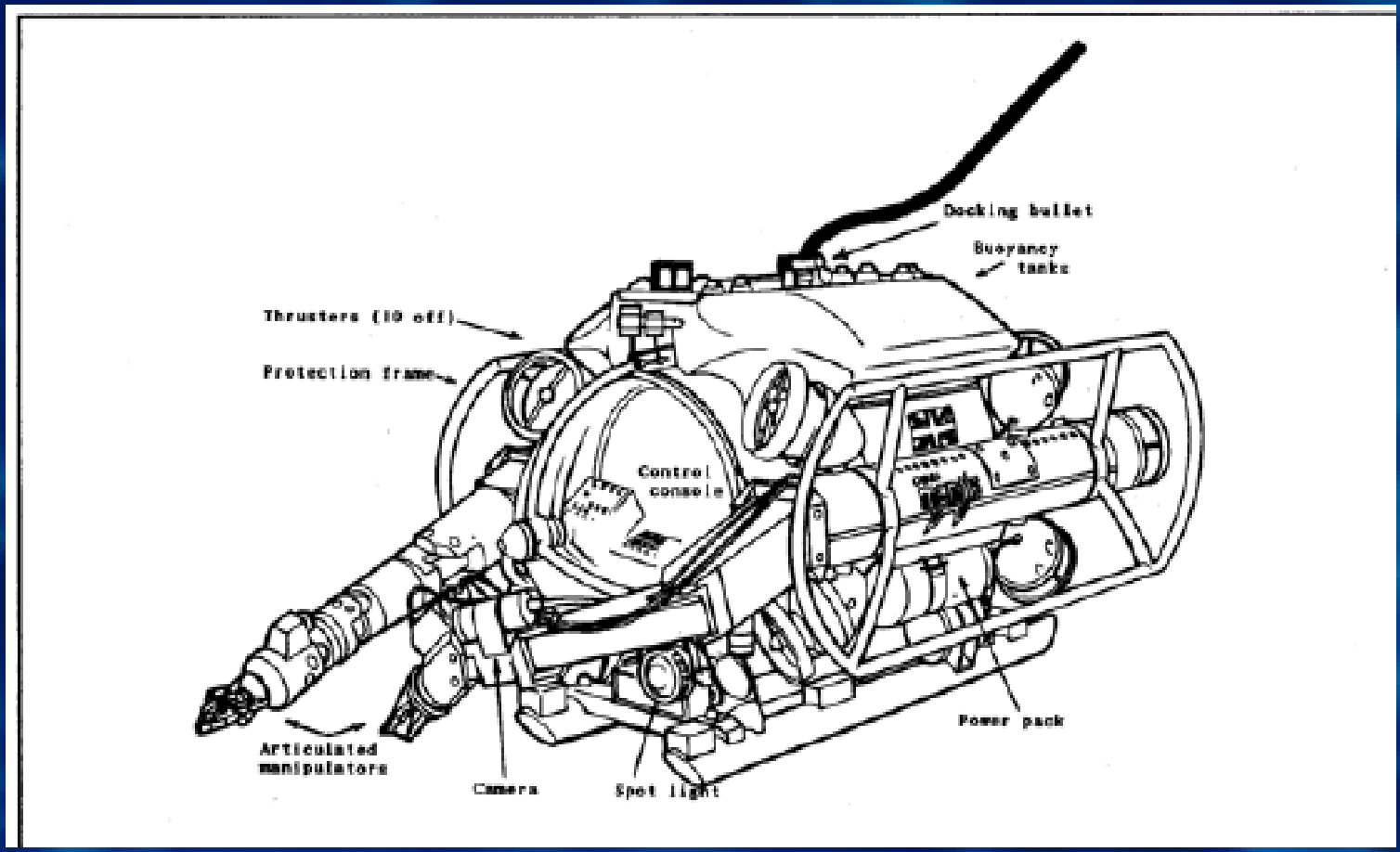
- These are unmanned underwater vehicles controlled from a remote location such as a ship, fixed offshore platform, floating platform, or other above water structure.

ROV's

- It is a mini submarine that can be controlled via an umbilical as shown in the Figure.

- It is a cost effective alternative to the deep sea diver.
- ROV's were further developed in the 1980's due to the emergence of the sub-sea wellhead.

- These wellheads can be installed, maintained and repaired entirely by ROV, ending the reliance on saturation divers and permitting the exploitation of reserves located in water depths beyond the range of conventional diving techniques.


Docking bullet
Buoyancy tanks
Thrusters (10 off)
Protection frame
Control console
Articulated manipulators
Camera
Spot light
Power pack

Classification

There are two ways to classify ROV's:
a) according to the means of propulsion b) according to function.

a) There are six categories:
Tethered (free swimming), see Figure 44: constitutes the large majority of ROV's. Connected to the surface by cable. Equipped with closed circuit video. Positively buoyant.

- Towed: propelled by surface vessel.
- Bottom reliant: power and control from surface vessel. Equipped with closed circuit video. Propulsion by wheels or tracks.
- Structure reliant: power and control from surface. Closed circuit video. Propulsion from wheels or tracks in contact with structure.
- Autonomous (untethered): self powered with 3-D maneuverability. No physical connection to surface.
- Hybrid: combination of above types.

b) There are 5 categories:

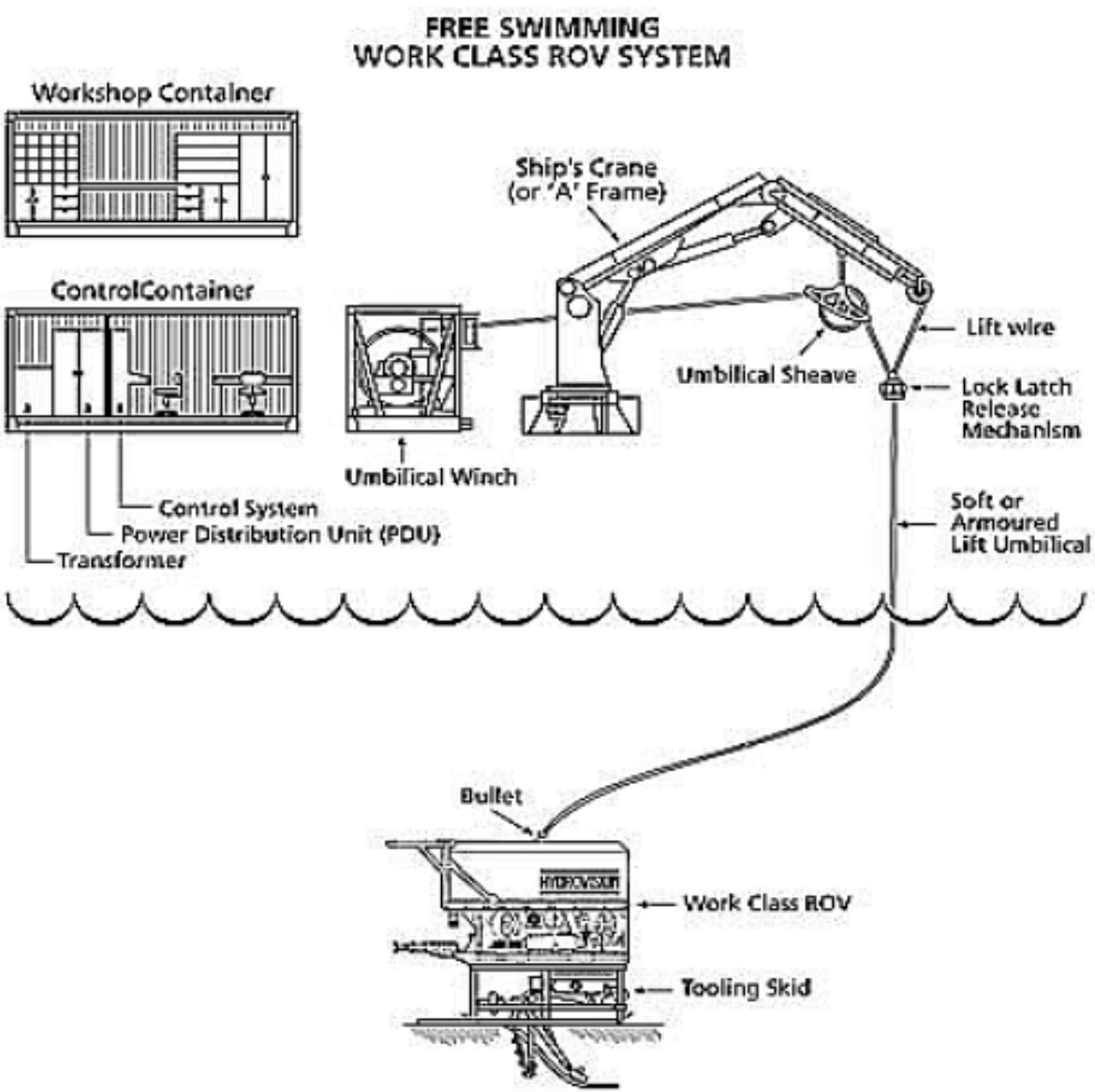
- Work class.
- Observation class.
- Drill support.
- Construction support.
- Pipeline and cable trenchers

AUV's

- An autonomous underwater vehicle (AUV) is a self-propelled, unmanned underwater vehicle controlled by an onboard computer. There is no tether. They are totally preprogrammed to think for themselves.

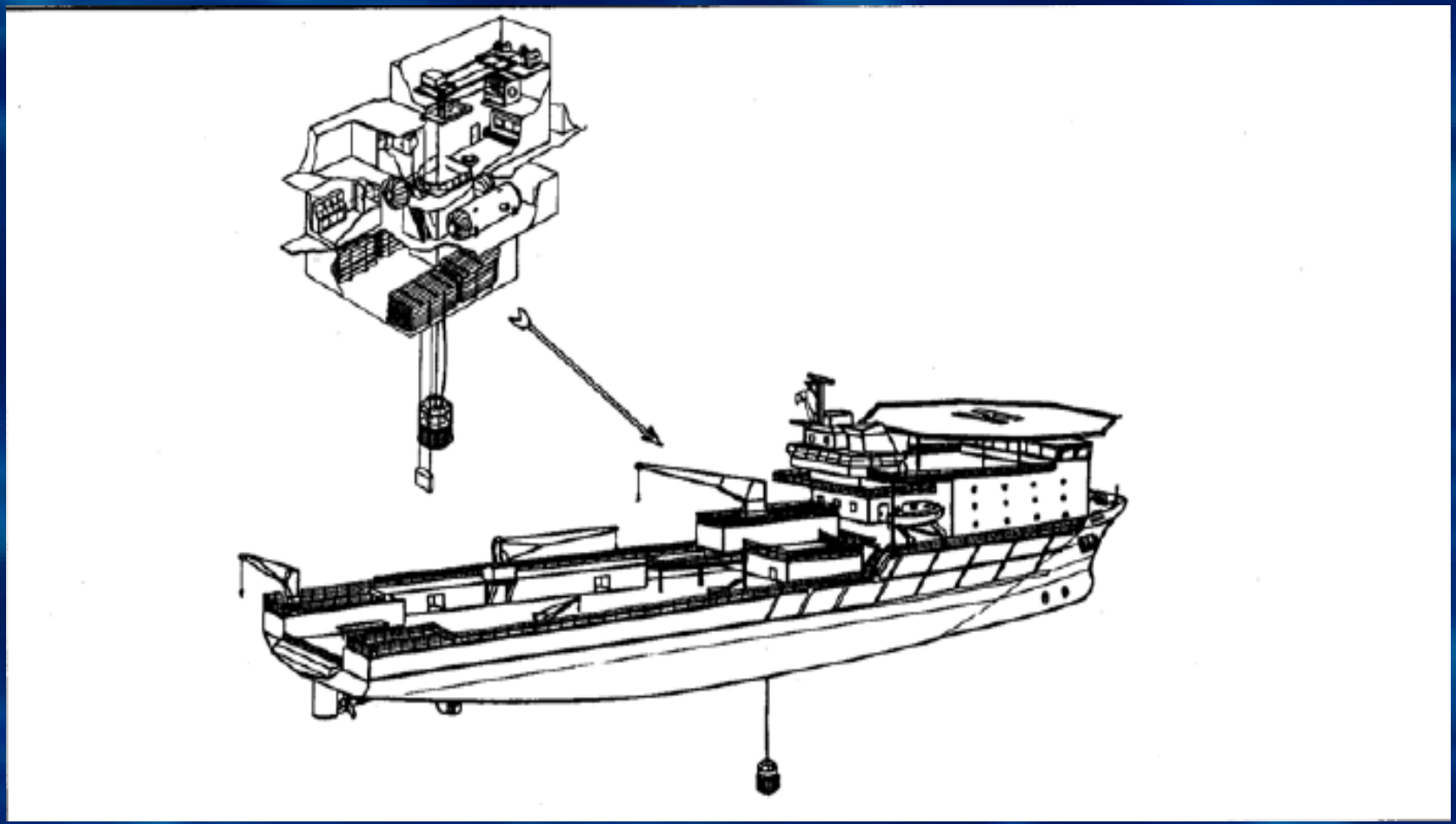
- The AUV entered the commercial market in late January 2001. It is used for surveying, inspection and can perform limited manipulator tasks. In case it fails in performing its task, it should be able to abort its mission and return to the surface.

- The major problem for AUV's is that they have limited power due to battery power/size ratios.


FREE SWIMMING
WORK CLASS ROV SYSTEM
Workshop Container
Ship's Crane
(or 'A' Frame)
ControlContainer
Lift wire
Umbilical Sheave
Lock Latch
Release
Mechanism
Umbilical Winch
Control System
Power Distribution Unit (PDU)
Transformer
Soft or
Armoured
Lift Umbilical
Bullet
Work Class ROV
Tooling Skid

Support Vessels

- Supply vessels are usually suited to air diving operations, provided they contain a DDC.
- Diving Support Vessel (DSV), is required, provided it is equipped suitably with DDC's, diving bell and ROV launchers.
- The DSV represents the diving company's single largest investment. The vessel should be capable of working in adverse weather conditions using hull stabilization equipment and dynamic positioning (DP). The vessel may have two moonpools: one
- for the deployment of diving bells and the other for deploying ROV's. Some DSV's are provided with well service equipment for sub-sea wells.



Underwater Work Tasks

ROV's usually carry out the following tasks:-

- Water Jet Cleaning
- Brush Cleaning
- Hydraulic Friction welding
- Dredging
- Hydraulic Cutters
- Hydraulic Socket Wrenches, Torque Wrenches
- NDT, Non Destructive Testing
- Seabed and Pipeline Survey

- Cleaning:
- This is usually performed using water jets or special brushes. Cleaning steel or concrete oil platforms or other structures (from marine growth) is very easy for an ROV to perform. Platform cleaning has been performed by several ROV companies since the mid eighties. It was performed on all kinds of Platform Node configurations from complicated K-nodes to straight leg sections.

- Welding:

  Modern welding techniques such as hydraulic friction welding have been developed for new offshore installations.

- Dredging:

  Work ROV's can be fitted with several different water suction dredging modules, a typical soil removal rate of 10 cubic meters an hour can be achieved.

- Hydraulic Cutters
- All work ROV's can carry different kinds of hydraulic cutters, the cutters range from rotary to shear cutting devices.
- A typical task for an ROV is to cut down lines during and after construction work under water. The choice of cutter depends on the type and access to the work piece due to be cut.

- Hydraulic Socket Wrenches, Torque Wrenches

  All Work ROV's can carry different kinds of hydraulic wrenches, this means that the ROV can undo nuts and bolts underwater even using the torque wrenches which will make up connections to any pre determined torque required for the bolt connection.

Seabed and Pipeline Survey

- *Seabed Survey:*
- The ROV can move along the seabed at high speeds without disturbing the seabed.
- The ROV can also carry all the sensors the surveyors require for the survey and the instruments can be monitored as the survey is performed. If any part of the survey is unsatisfactory or any point of special interest has been found the ROV can return to this point for further investigation.

Pipeline Survey

- In the offshore oil environment the ROV is used for pipeline surveys utilising sidescan sonar, odometers, GPS navigation systems, video and still camera photography and other NDT equipment.

- The ROV is also utilised before the pipeline is put on the seabed to make sure that the pipeline does not end up on top of debris or a rocky seabed, if any obstacles are detected the pipeline engineers can change the position of the pipeline before the pipe laying is started.